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A PERIODIC TABLE FOR FUNDAMENTAL PARTICLES

BY

JOHN J. GREBE

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Gravity, inertia, nuclear structure, and the nature of the conversion of energy to matter and of matter to energy all present such intriguing challenges to the imagination that for forty years I have been continually searching for a better understanding. The state of the art in this field is well summarized by its experts when, for example, Marshak[1] writes in the *Scientific American:* "Our mathematical techniques cannot effectively handle more than one pion at a time. Beyond this, things become much too complicated. The problem appears to be a basic one, and it seems that only some radically new idea will enable us to solve it;" and when Gell-Mann and Rosenbaum[2] also state in the same publication: ". . . it will probably require some wholly new ideas. For one thing, many theoreticians believe that the present concepts may be entirely inapplicable at extremely short distances—of the order of the dimensions of the particles. In fact, it is suspected that here these concepts become self-contradictory."

Fundamentally, I am confident that nature is so beautiful and orderly and ultrasimple in its make-up that anything requiring complicated devices to explain it lacks some of the plain unity inherent in that basic structure. Consequently, I began with the concept that gravity is nothing but electromagnetic attraction between currents based on oscillating or rotating charges at an ultrahigh frequency of about 10^{24} cps.[3] Nothing can produce, sense, or absorb this energy except the elemental particles themselves; it amounts to the high-frequency alternating component of the electromagnetic field of which the nuclear magnetic moments, which have been so extensively measured, are merely the DC and low-frequency components – the average effects. This energy is like the lights of a merry-go-round—large swirls when seen from a great distance, while the close-up shows cyclic motions, twirls within the over-all swirls.[4]

For a better understanding of these subquantum mechanics,[5] I searched among the only data that might be of help, namely, the mass and decay data on the fundamental particles. Since all matter consists principally of protons and neutrons, my postulate that gravity and inertia are based on the high-frequency electromagnetic field around and within each proton and neutron implies that all other elemental particles must be cognizant of and must conform to the forces of this field. If their geometry did not match this all-pervading field, they would not survive even a few cycles, just as a stone skipping on ripples of water either

skips on the crests or sinks. On the basis of this assumption, I studied the many interrelations to be found between the 14 distinct masses of these particles, some of which are known to within 20 ppm.

Among the hundreds of geometric relations studied,[6] two key ratios were found. The ratio between the masses 206.86±0.11 of the μ meson and 264.37±0.6 of the π^0 meson, and that between the proton mass 1836.12±0.04 and the Σ^- hyperon mass 2342±1.5, each proves to be almost equal to $\frac{\pi}{4}$.

A search for a single mathematical progression connecting these ratios failed at first, but such a progression was located months later when it was discovered that $\sqrt{\frac{\pi}{4}}$ is the common base. Plotting the inverse (to eliminate negative exponents), the powers of $\left(\frac{4}{\pi}\right)^{1/2}$, as integer powers from 0 to 64 and allowing for pairs of elemental charges provided a scale for the mass values. It was found that a slight modification of the $\left(\frac{4}{\pi}\right)^{1/2}$ value, called the constant g = 1.12888, was required to match the values more accurately. Surprisingly enough, this progression recognizes the decimal system: $g^{19} = 10$, $g^{38} = 100$, $g^{57} = 1000$. This alone is a subject for extended mathematical-philosophical discussions.

Four particles that required special analysis and treatment remained. The proton differs from the neutron by a single charge. If we assume this to be a single electron with its relativistic mass, the difference becomes 2.53±0.08 electron masses, which is very close to the value of $g^8 = 2.6414$. This would make the neutron = $n = 2g^{62}$ and the proton = $p = 2g^{62} - g^8$.

Doubling this value of 2.6414 for a pair, the elemental plus and minus charges (the positron and the electron spinning around one another in 1 or more of the possible ways in what is called positronium), would give a mass of 5.2828 for what might be considered a unit. This unit represents the mass of a plus and minus charge at approximately 0.925 times the velocity of light (c). The mass of an electron moving at $\frac{\pi}{4}$c, or 0.7854 times c, is 1.6155 electron masses m_e. This, doubled for the pair, gives 3.231.

Dividing this mass which, after all, is closely related to g, into the various particle masses shows that the K-meson $4g^{51}$ gives a number 148.7 for the possible content of such pairs. The exponents that appear to be used by nature for its most stable particles

$$- u = g^{44},\ \pi^{\pm} = \tfrac{1}{2}g^{52},\ p = 2g^{62} - g^8 -$$

are roughly in the ratio of $\sqrt{2}$, $\sqrt{3}$, and $\sqrt{4}$ to one another. They are also related to the corresponding masses by fractional powers varying between the sixth and eighth. Squaring these ratios to obtain what might be a dimension results in the ratios 2, 3, and 4. If these ratios are used as the 3 dimensions for a solid of fixed shape, for instance, the diameter

of a ball, they would still require an additional dimension to make it possible to match the corresponding masses. This variable can be a time-related function such as velocity. Of this variable, we have given two examples, 0.7854c and 0.925c.

The value $\left(\frac{\pi}{4}\right)^{1/4}c$, which is 0.941c, gives an electron mass of 2.96, which corresponds to g^9. This would make the mass of the pair 5.93 m_e. Dividing $2g^9$ into the mass of the proton remaining after the subtraction of 1 g^8 results in the number 309.

Similarly, dividing g^{11} into 206.86 gives us the number 54.5. This series – 54.5, 148.7, and 309 – is highly reminiscent of a relation pointed out some years ago by R. B. Fuller[7] in a report explaining the problem of building into a structure the maximum strength and rigidity with the least material. Fuller's solution involves the equivalent of tripods or balloons placed in a closely packed cubic pattern, as shown in FIGURES 1 through 4. FIGURE 1 shows a packing of 6 balls around 1 central ball in a single plane. FIGURE 2 shows 12 balls covering and completely surrounding the center, thus comprising the first layer, a total of 13 balls. FIGURE 3 shows the 42 balls required for the second layer, making a total of 55 balls. The third layer (FIGURE 4) requires 92 balls, making a total of 147 balls.

The fourth layer uses 162 balls, making a total of 309. This shows that these models could represent the structure of the so-called elemental

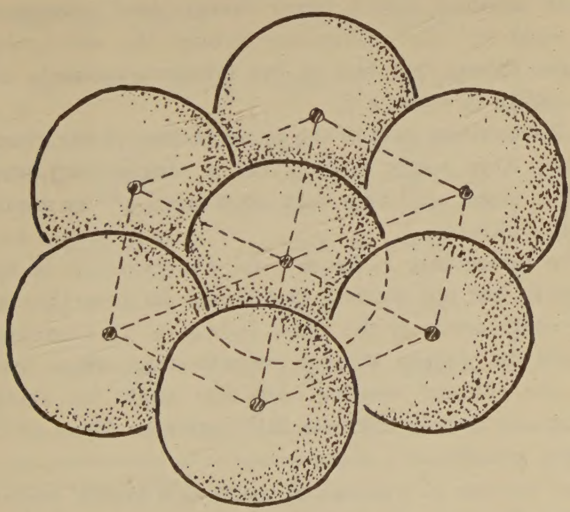


FIGURE 1. Two-dimensional closest packing of equal spheres around a nucleus forms regular hexagonal patterns. Spheres can be considered as expanded vertexes of the equilateral triangles. Reproduced by permission of R. B. Fuller.[7]

particles mathematically, although not necessarily physically — too little is known to say that. However, it does seem as if these successive layers are significant in the properties — particularly the slow neutron cross sections — of isotopes, from the smallest nuclear masses to those of the twenty-sixth shell, and including both lead and bismuth (TABLE 1).

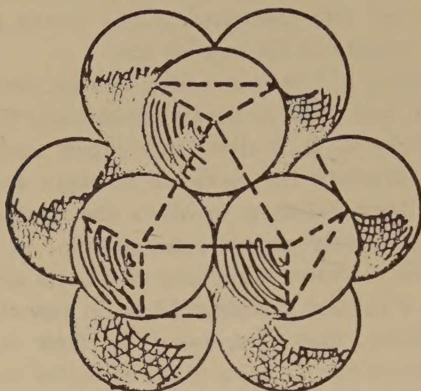


FIGURE 2. Omnidirectional closest packing. Twelve balls in first layer surrounding nucleus. Reproduced by permission of R. B. Fuller.[7]

The proton would be $308 \cdot 2g^9 = 308$ positronium pairs at g^9 energy level, and one positron with a lower energy level corresponding to g^8. The neutron $= 308 \cdot 2g^9 + 2g^8$. Checking through the energy levels for the remaining mass values that fall on the integer exponents of g produces the summary shown in TABLE 2.

TABLE 2 describes most of the upper portion of the chart of FIGURE 5 (center fold). One might expect that a single-shell structure could also exist. This might well be a very short-lived g^{32} or similar structure, with the likely multiples.

It will be interesting to learn what observations of mass numbers have been made but not trusted that would fit into this upper portion and in many other areas of the chart (FIGURE 5). Considerable understanding could be gained through reports from other laboratories of values that are not yet verified, but that might be established with sufficient accuracy to help evaluate this fantastic dream of "quantizing" the fundamental particles.

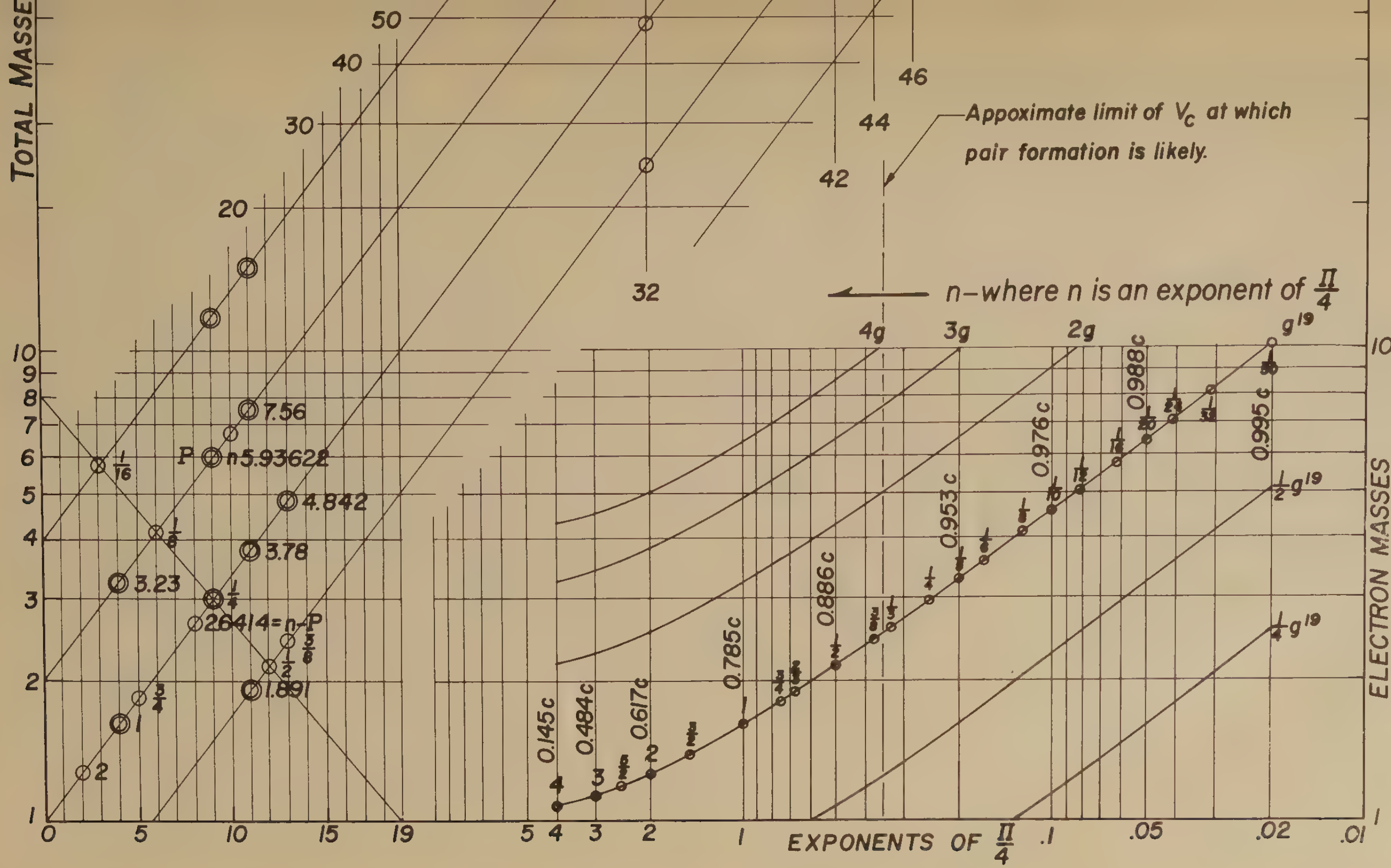
The lower section of FIGURE 5 provides a highly revealing picture. In addition to g^4, which is the mass of a charge at $\left(\frac{\pi}{4}\right)$ c, we have g^9, the mass of a charge at $\left(\frac{\pi}{4}\right)^{1/4}$c. Here again a slight correction is required, which in itself becomes a very interesting study. We also have g^8, the difference between the neutron and proton masses, indicating

TABLE 1

Shell no.	*Isotopes found at or near the completion of any one shell*	*Units in last shell*	*Total units including this shell*	*No. of proton + neutron masses*
1	g^{31}, g^{32}, g^{33}	12	13	0.042
2	μ, π^0	42	55	0.178
3	K, $\pi^{\pm}$, λ, Σ^0, Ξ^-	92	147	0.476
4	p, n, Σ^-, H	162	309	1.000
5	D^2	252	561	1.817
6	He^3	362	923	2.990
7	He^4	492	1415	4.584
8	Li^7	642	2057	6.663
9	Be^9	812	2869	9.294
10	C^{12}	1002	3871	12.540
11	O^{16}	1212	5083	16.466
12	Ne^{21}	1442	6525	21.137
13	Mg^{26}, Al^{27}	1692	8217	26.618
14	S^{33}	1962	10179	32.974
15	Ca^{40}, A^{40}, K^{40}	2252	12431	40.269
16	Ca^{48}, Ti^{48}, Ti^{49}	2562	14993	48.568
17	Fe^{57}, Fe^{58}, Ni^{58}	2892	17885	57.937
18	Zn^{68}, Ga^{69}	3242	21127	68.439
19	Kr^{80}, Se^{80}, Kr^{82}, Br^{81}, Se^{82}	3612	24739	80.139
20	Zr^{92}, Mo^{92}, Mo^{94}, Zr^{94}, Nb^{93}	4002	28741	93.103
21	Ag^{107}, Pd^{108}, Cd^{108}	4412	33153	107.396
22	Sn^{122}, Te^{122}, Sb^{123}	4842	37995	123.081
23	Ce^{140}	5292	43287	140.224
24	Gd^{158}, Dy^{158}, Tb^{159}, Dy^{160}	5762	49049	158.889
25	Hf^{180}, Ta^{180}, W^{180}, Ta^{181}	6252*	55301*	179.142*
26	Hg^{201*}, Tl^{204}, Pb^{204*}, Bi^{209}	6762*	62063*	201.046*

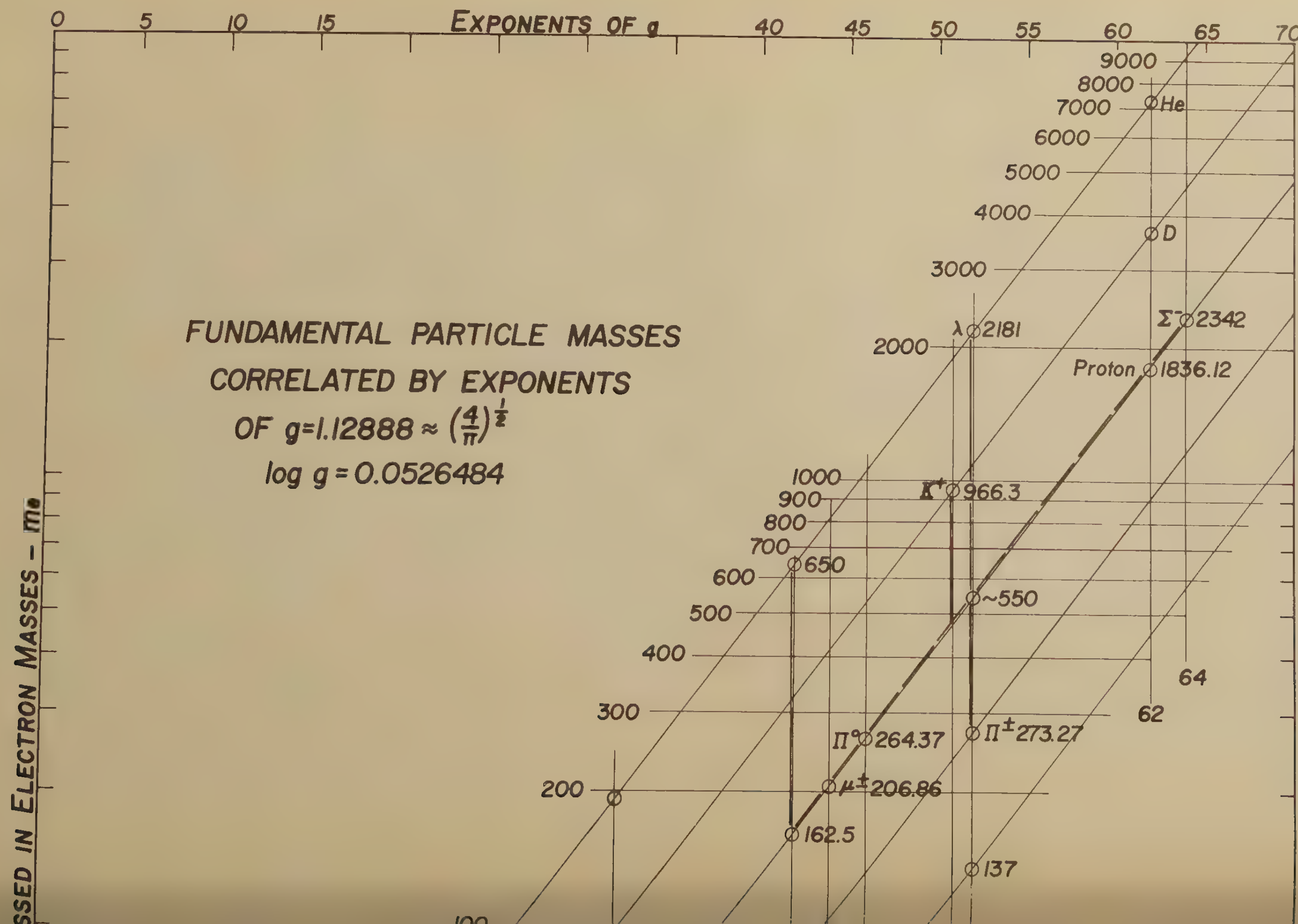
*Due to the large faces of the basic cube holding up to 6×21^2 units with higher gravitational forces than those on edges.

that the stable proton has two energy levels represented in it. A whole series of g values falls on the various powers of $\frac{\pi}{4}$ from 4 to $\frac{1}{16}$ multiplied by c for the velocity of the unit.



TOTAL MASSE
Appoximate limit of V_c at which pair formation is likely.
n–where n is an exponent of $\frac{\Pi}{4}$
P n5.93622
26414=n-P
7.56
4.842
3.78
3.23
1.891
0.145c
0.484c
0.617c
0.785c
0.886c
0.953c
0.976c
0.988c
0.995c
4g
3g
2g
g^{19}
$\frac{1}{2}g^{19}$
$\frac{1}{4}g^{19}$
EXPONENTS OF $\frac{\Pi}{4}$
ELECTRON MASSES

FIGURE 5.


FUNDAMENTAL PARTICLE MASSES
CORRELATED BY EXPONENTS
OF g=1.12888 ≈ (4/π)^1/2
log g = 0.0526484
EXPONENTS OF g
0
5
10
15
40
45
50
55
60
65
70
SSED IN ELECTRON MASSES – me
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
He
D
λ 2181
Σ⁻ 2342
Proton 1836.12
K⁺ 966.3
650
~550
Π° 264.37
Π± 273.27
μ± 206.86
162.5
137
62
64

In the K-meson the g^4 value for a single charge may be used 4 times, representing two positronium pairs, or a single pair with 2 neutral "electrons," in 1 unit. This represents a structure very like that of helium, the scale of which is 309 times as large. Among the L-mesons, the three lightest particles of which are known to differ considerably from the rest by having no additional antiparticles of both plus and minus charges, the g values 11 and 13 represent the highest states of excitation that seem to be used in this entire correlation. Apparently this energy is in one of several forms that are difficult to evaluate at present.

At g^{12} one finds the square root of $\left(\frac{\pi}{4}\right)^{1/2}c$, again with a minor but significant correction. This value is not used except possibly as the energy of part of the shells in $\Sigma^0 2323 \pm 7$. This hyperon seems to be a partially excited state of λ. $\Xi^- 2583 \pm 5.5$ appears to be the λ meson at an even higher energy with the main mass at g^{12} that corresponds to $\left(\frac{\pi}{4}\right)^{1/2}c$ and all the outer shells at an energy of g^{13}. Another structure that would explain the Σ^0 and the Ξ^- hyperons would be the sum of $\lambda + 1$ and $2\,\pi$ mesons at higher energy states.

$\Sigma^+ 2327 \pm 1$ can be explained in at least 2 ways. Either it lacks 2 pairs of the 309 in $\Sigma^- 2342 \pm 1.5$, or it has the central 13 pairs at the energy level g^{10}.

It is difficult at this time with the very limited information at hand to differentiate between such explanations.

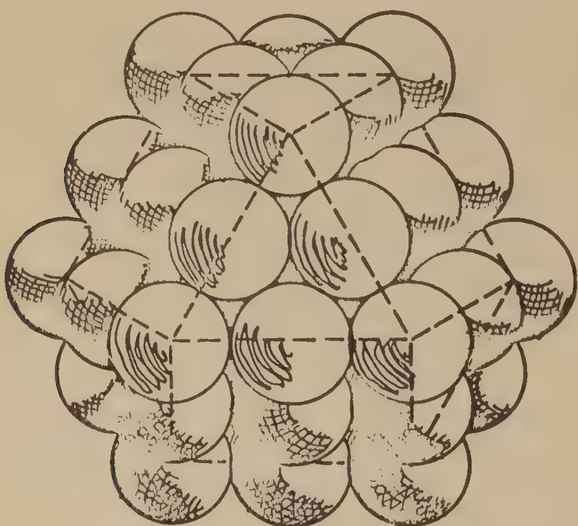


FIGURE 3. Omnidirectional closest packing. Forty-two balls in second layer surrounding nucleus. Reproduced by permission of R. B. Fuller.[7]

TABLE 2

Possible structure	g exponents for mass	Ratio	Possible shells	Particle	Mass calculated from g	Mass measured or calculated from $f\left(\frac{\pi}{4}\right)c$
g^0	0	–	0	electron or positron	unit	1.0
g^4	4	–	0	electron at $\frac{\pi}{4}c = 0.7854$	1.6245	1.6159
g^8	8	–	0	electron at $0.925c = \eta - p$ at $\left(\frac{\pi}{4}\right)c$	2.6414	2.53 ±0.08
g^9	9	–	0	electron $0.9403c = \left(\frac{\pi}{4}\right)^{1/4}c$	2.97737	2.9664
g^{11}	11	–	0	electron at 0.96c	3.7943	–
g^{13}	13	–	0	electron at 0.98c	4.8353	–
$55{\cdot}4g^9$	42	–	2	newly established mass	652.96	≈650
$55g^{11}$	44	$\sqrt{2}$	2	the muon, $\mu\pm$	207.25	206.86 ±0.11
$55g^{13}$	46	–	2	the π^0 pion	264.14	264.37 ±0.6
$147{\cdot}2g^4$	51	–	3	half of a K-meson	484.2 968.4	– 966.3 ±1.4
$147{\cdot}2g^5$	52	$\sqrt{3}$	3	a meson of 546.66 mass	546.66	≈550
$147{\cdot}g^5$	52	–	3	above, halved making π^+ and π^-	273.33	273.27 ±0.11
$147{\cdot}8g^5$	52	–	3	the λ hyperon $= 4g^{52}$	2186.64	2181 ±0.1
$308{\cdot}2g^9$ $+1{\cdot}g^8$	62	2	4	proton	ref. pt.	1836.12 ±0.04
$309{\cdot}2g^{11}$	64	–	4	the Σ^- hyperon	2341.52	2342 ± 1.5
$307{\cdot}2g^{11}$	$64-4g^{11}$	–	<4	the Σ^+ hyperon	2326.34	2327 ± 1.0

Having covered the basic table with some first-order modifications, we can now consider second-order modification. To do so is much like studying the "mass defects" of the Mosely Series in the table of isotopes, although that scale is 309 times larger than the one with which we are concerned.

Part of this second-order modification appears to be energy of combination, especially in those instances where 2 or more entities larger than the positronium pair are combined in 1 structure with increased packing density.

Another part, and it is only a part, can be accounted for by the modification of $\left(\frac{4}{\pi}\right)^{1/2}$ to obtain the g value; this amounts to about 5 parts in 1838. Further second-order modification seems to be due to an energy content that can be ascribed to the motion of the positronium pairs that gives a rolling over of the entire assembly, a wobble in the orbits, and to energy absorbed in combination with the remainder of the pairs associated with it in the particular body in which it is located.

It is far too early in this study to make second-order corrections. Much more data are required than we have been able to glean as yet from the mass values with which we have worked. It must be remembered that our problem is very like that of establishing the regularity that might exist in 11 piles of bricks of which we know the total weights, and which we suspect were all made by a single machine. This corresponds to the gravitational electromagnetic field of an ultrahigh frequency and of a wave length corresponding to the dimensions of these bricks. We know nothing about either their density or the number of bricks in each pile.

All the foregoing is the result of such a study. It may be a completely wrong picture, but a great many other combinations that were tried did not meet the specification of providing a very simple solution. It matters little whether the particular explanations associated with the mathematical relations presented actually do prove finally to give the correct picture, so long as they provide a stepping stone toward the correlation of a great deal of additional data on particle masses and behavior not yet established with sufficient reliability to be reported in the literature. These may well fit into the many empty spaces of this partially filled Mendeleev Table and Mosely's Chart, with energy and velocity spectra showing fixed and uniform exponential intervals of mass relations. Consequently, even if only that portion of this presentation dealing with the facts presented is accepted and the mechanical model used for explanation is omitted, my purpose will have been achieved.

On the other hand, if such a model does have some significance, then one can easily visualize inertia as the acceleration of an already rapidly moving body that occurs when matter, consisting of many gyro-

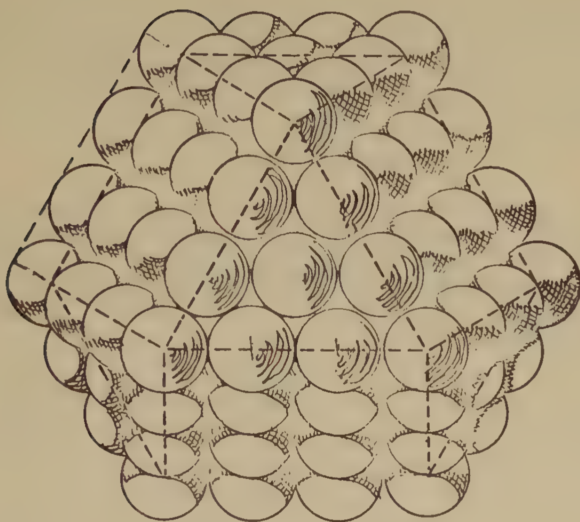


FIGURE 4. Omnidirectional closest packing. Ninety-two balls in third surrounding layer. One ball: nucleus; 12 balls: first layer (radius = 1); 42 balls: second layer (radius = 2); 92 balls: third layer (radius = 3); 162 balls: fourth layer (radius = 4); 252 balls: fifth layer (radius = 5). Subtract common 2 from each total, then divide by 10; the remaining numbers (1, 4, 9, 16, 25) are the squares of the corresponding radii. The number of balls in any layer = $(\text{radius}^2 \times 10) + 2$. Reproduced by permission of R. B. Fuller.[7]

scopes geared to a synchronous field, is further accelerated in relation to the geared and meshed grid of electromagnetic standing waves that provides gravitational forces. This interpretation makes it easy to understand why gravity cannot be shielded, although it operates within the laws of electromagnetic attraction.[8] Even more complete and realistic explanations result if the entire process is expressed with the electrostatic equations of forces.

The whole picture, known for many years, of the conversion of energy into matter by pair formation and the annihilation of matter by its conversion into energy, which has been so ably demonstrated at the University of California, Berkeley, California, during the last few years, becomes familiar because of our long association with the production and decay of elemental charges. It gives one great confidence to know that the only indivisible matter with which we have dealt appears to be that of the electron and positron, which are 1836.12 times lighter in mass than that paragon of stability, the proton, the nucleus of hydrogen.

Of course, a number of attempts to explain the structure of matter in terms of electrons and positrons as building blocks have been discarded. This theory[9] may also be discarded. However, the mathematical relations discovered are bound to remain, and they can serve as a useful step toward further understanding.

Summary

The existence of unique relations among the fundamental particles based on exponentials of $\frac{\pi}{4}$ has been discovered in the search for symmetry, unity, and simple structure. For example: $\frac{\pi}{4} = 0.7854$; $\frac{206.86 \pm 0.11}{264.37 \pm 0.6} = 0.78246$; and $\frac{1836.12 \pm 0.04}{2342 \pm 1.5} = 0.78399$.

The proton mass multiplied by $\frac{4}{\pi}$ gives the Ξ^- hyperon value of 2342 in terms of electron masses. The proton mass = 1836.12 multiplied by $\frac{\pi}{4}$ five times gives the value of a newly proven particle, mass ≈ 550, which appears to be twice the $\pi^{\pm}$ meson of mass = 273. This multiplied by 4 is 2186.0 for the λ hyperon; 273 multiplied 3 times by $\frac{\pi}{4}$ gives the π^0 meson mass 264. One more $\frac{\pi}{4}$ relation gives the mass of $\mu^{\pm}$ meson = 207. Finally, multiplication by $\frac{\pi}{4}$ once more, and then by 4, leads to the newly established particle of mass ≈ 650.

The well-studied K-mesons differ from the $\pi^{\pm}$ mesons by a factor of 4 and $\sqrt{\frac{\pi}{4}}$. This explains the masses of all the well-established particles, except for the 3 that appear to have 2 or more energy levels represented in them, or those that appear to be the sum of 2 or more different particles mentioned.

The common denominator of all these masses appears to be a particle of a mass equal to the electron and orbiting at discrete velocities, the most prominent of which is the fourth root of $\frac{\pi}{4}$ times the velocity of light, c. This = 0.941c, giving a total mass = 2.968 times the rest mass. Dividing such a unit into the 3 particles that appear to have the same level of energy gives us the numbers of ≈ 55, 147, and 309. These are exactly the numbers of balls that pack around a central ball upon the addition of the second, third, and fourth successive layers of balls.

An allowance for 27 concentric shells would account for the structure of the nuclei of all the elements. Isotopes with complete or nearly complete shells show low neutron cross section, as illustrated by the fourth, H; the fifth, D^2; the sixth, He^3; the seventh, He^4; the eighth, Li^7; the ninth, Be^9; the tenth, C^{12}; and the eleventh, O^{16}.

If one is willing to acknowledge the possibility that electron and positron pairs may replace some or all of the neutral particles, these pairs become the common denominator and exhibit 3 principal energy levels. One can thereby explain gravity, inertia, and "nuclear glue" as electromagnetic force at the ultrahigh frequency of 10^{24} cps. This

explanation of the material of the universe would consequently be based upon electrons and positrons orbiting at a velocity of the fourth root of $\frac{\pi}{4}$c with a relativistic mass almost twice that of their rest mass. Very slight "mass defect" relations appear significant in understanding structures and stabilities.

Concluding Remarks

In the above presentation, I have tried to avoid any explanation of the fundamental why and how by merely stating the analysis of the data and one possible sequence of geometric configurations based upon it. However, one of the many possible explanations can be formulated by evaluating the following concepts, which were assumed for the purposes of my analysis.

The fact that the known wave lengths of electrons and positrons are so very much longer at the energies mentioned than the measured values at the diameter of the nucleus may seem as perplexing as the presence of a charge in protons, and even in the far lighter mesons. Such a wave length simply cannot exist according to the well-established wave lengths of electrons, but the charge must be contained.

The spinning charges both singly and in multiple can be compared to a wave re-entrant upon itself like a hoop snake, being pulled into the smallest possible path by the pinch effect. Two such charges can then surge around one another as do particles in a vortex. In addition, the rings — charges — may rotate in the plane of the vortex at $\left(\frac{\pi}{4}\right)^{1/4}c =$ 0.9414, the velocity of light.

To carry the comparison further, the diameter of this vortex then represents the length of the all-pervading, standing-wave, space lattice. As such it would be about one ninth the diameter of the proton or neutron. This diameter also corresponds to the wave length associated with the neutrino.

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